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area of the channel opening are determined by the via entrant angle"
[underlining added for clarity]

The above provides at least four limitations not taught or suggested by APA and Wang: first, a limitation that includes a unique definition of a via entrant angle; i.e., an angle of the line of the rims of the channel and via with the bottom of the channel; second, a limitation that includes a specific range for the via entrant angle; third, a limitation that includes the formation of a collimator for the via; fourth, a limitation sizing the channel based on the previously defined via entrant angle.

With regard to APA, the Examiner in Office Action page 3, item #3, second paragraph, correctly states:

"However, the Admitted Prior Art (figures 1A-1C and pages 1-7 of the specification) do not explicitly teach the via having a via entrant angle formed from a rim (unlabeled) of said channel opening to a rim (unlabeled) of the via and a horizontal bottom of the channel opening of greater than about 69 degrees."

It is respectfully submitted that the APA also does not implicitly teach or suggest either the via entrant angle as claimed or the via entrant angle greater than about 69 degrees. APA FIGs. 1A-1C show that the lack of knowledge of the via entrant angle caused void formation shown in FIG. 1C and explained on APA page 3, lines 10-23:

"The common problems associated with most of the seed layer deposition techniques are poor sidewall step coverage and conformality . . . As the width of the channels and vias have decreased in size due to the size reduction in the semiconductor devices, an excessively thick seed layer in the wide-open areas interferes with the subsequent filling of the channel and vias with conductive materials leading to the formation of voids. These voids lead to connection and electro-migration failures.

A solution, which would form uniform seed layers in vias and result in an improvement in the subsequent filling of the vias by conductive materials, has long been sought, but has eluded those skilled in the art."[underlining and deletion for clarity]

Thus, APA discloses the problems and indicates that "[a] solution...has long been sought, but has eluded those skilled in the art." Therefore, APA does not teach or suggest a solution or the first and second limitations. If the Examiner believes these limitations are present in APA, citation of the specific paragraph(s) is requested pursuant to MPEP §2144.03.

Further, APA does not teach or suggest the third or fourth limitations related to the formation of a collimator or the sizing of the channel.

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With regard to Wang, the Examiner in Office Action page 3, item #3, second paragraph, incorrectly states:

"Wang (5629327) teaches a via hole 35 having an entrant angle of less than 90 degrees, which include (sic) an overlapping range of the claimed subject matter. See column 1 (sic) and figure 5."

It is respectfully submitted that Wang does not teach "a via hole 35 having an entrant angle" and does not teach an "angle of less than 90 degrees, which include an overlapping range of the claimed subject matter."

Wang states in col. 1, lines 31-50:

"The importance of beveled contact holes has been recognized for some time and many have worked on methods of achieving them. U.S. Pat. No. 5,180,689 to Liu et al shows... The current invention uses a wet etching step with a greater lateral etch rate than vertical etch rate as a first step in forming the tapered contact via hole. The wet etching prevents the formation of the re-entrance profile and provides an angle of entrance into the contact via hole of less than 90°."

The above discloses, with Wang FIGs. 2-10, that Wang teaches a beveled contact hole (via) where the "angle of entrance" is the angle of the bevel. The "angle of entrance" does not disclose an "entrant angle" of a line of the rims of a channel and a via with the bottom of a channel. More specifically, Wang does not disclose a channel, a rim of a channel, or a bottom of a channel to which the Wang "angle of entrance" can be correlated.

Since the claimed angle of 69° relates to subject matter including an entrant angle of a line of the rims of a channel and a via with the bottom of a channel, the Wang 90° angle of entrance of the bevel cannot overlap the range of the "claimed subject matter".

Assuming *arguendo* that there is some type of overlap of the claimed subject matter, the C.C.P.A. has held that "ranges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results." (*In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (C.C.P.A. 1976) at 100 (citing *In re Malagari*, 499 F.2d 1297, 182 USPQ 549 (C.C.P.A. 1974); *In re Orfeo*, 440 F.2d 439, 169 USPQ 487 (C.C.P.A. 1975)). It is respectfully submitted that the Applicant's disclosed range shows criticality in the claimed range because:

"It has been determined that in order to achieve the channel collimator effect, it is necessary that the via entrant angle 69 from the rims 132 to the rim 134 as shown in FIG. 2, must be approximately 69 degrees or greater so as to

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provide the via entrant angle 70° as shown in FIG. 3 of at least 70 degrees over the adhesion/barrier layer 138. As would be evident, with higher aspect vias where the depth is much greater than the via diameter, the via entrant angle should be increased." (Specification, page 8, lines 3-9, underlining added)

As would be evident to those having ordinary skill in the art from the above disclosure, the "less than 90° angle of entrance" of Wang would include angles less than the "greater than about 69°" via entrant angle. These Wang angles, which are less than the Applicant's via entrant angle, would be inoperative according to the present invention.

Neither APA nor Wang discloses, teaches, or suggests that the channel opening forming a collimator or that a via entrant angle determines the depth and a cross-sectional area of the channel opening. Therefore, APA and Wang both, individually, lack relevant teachings regarding these limitations.

If the Examiner believes that the combination of limitations are present in the combination of APA and Wang, this belief must be based on the Examiner's personal knowledge of which the Examiner is taking official notice since there is no such disclosure, teaching, or suggestion in APA and/or Wang. Applicant respectfully requests an Examiner Affidavit pursuant to 37 CFR §1.104(d)(2) (2002) disclosing the Examiner's personal knowledge.

Based on the above, it is respectfully submitted that claim 1 is nonobvious because neither APA nor Wang contains a relevant teaching, which can be combined as required by *In re Fritch*, *infra*.

The Examiner summarized the criteria for determining obviousness under 35 USC 103(a) based on the considerations established in *Graham v. John Deere Company*, 383 US 1, 148 USPQ 459 (1966).

Applicant traversed the rejections on the basis that all four *Graham v. John Deere Company* factors show the nonobviousness of Applicant's claims as explained in the Applicant's Response of December 12, 2001, which is incorporated herein by reference thereto. Essentially, with regard to:

1. Determining the scope and contents of the prior art: The scope and contents of APA disclose a rectangular channel intersecting with a cylinder and Wang discloses a beveled via in a flat surface.

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2. Ascertaining the difference between the prior art and the claims at issue: APA and Wang do not teach, suggest, or mention a combined structure, which could be read on by the four claim limitations above.
3. Resolving the level of ordinary skill in the pertinent art: Those of ordinary skill in the pertinent art would be those skilled in the semiconductor device manufacturing art who have been unable to solve the problem solved by the Applicant's claimed invention as admitted by APA (APA page 3, lines 21-23).
4. Considering the objective evidence present in the application indicating obviousness or nonobviousness: The APA admits that a solution to uniform formation of seed layers in vias has long eluded those skilled in the art and thus, that the Applicant's claimed invention is nonobvious (APA page 3, lines 21-23).

Therefore, it is respectfully submitted that Applicant's claimed invention is unobvious under *Graham v. John Deere Company*.

Applicant further traverses the rejections since the law applied by the Examiner is not current and is incomplete. It has also led to an erroneous conclusion.

The Examiner states in the Office Action page 3, item #3, last paragraph:

"The courts have concluded that there is no requirement that a motivation to make the modification be expressly articulated. The test for combining references is what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the art. In *re* McLaughlin, 170 USPQ 209 (CCPA 1971). Also, references are evaluated by what they suggest to one versed in the art, rather than by their specific disclosures. In *re* Bozek (163 USPQ 545 CCPA 1969)." [underlining added]

As recently as February of 2002, the Court of Appeals for the Federal Circuit (CAFC) vacated a judgment of the Board of Patent Appeal and Interferences (Board) in *In re Sang-Su Lee*, 277 F.3d 1338 (Fed. Cir. 2002) because the Board had erroneously held that "the conclusion of obviousness may be made from common knowledge and common sense of a person of ordinary skill in the art without any specific hint or suggestion in a particular reference." [underlining added]

The CAFC held that a showing of a suggestion, teaching, or motivation to combine prior art references is an essential component of an obviousness holding. The CAFC

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emphasized that this need for specificity pervades precedential authority and reinforced the requirement that teachings of reference can be combined only if there is some suggestion or incentive to do so (citing *In re Fine*, 877 F.2d 1071, 1075, 5 USPQ2d 1596, 1600 (Fed. Cir. 1988)).

That precedential authority includes: *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1124-25, 50 USPQ2d 1456, 1459 (Fed. Cir. 2000) ("a showing of a suggestion, teaching, or motivation to combine the prior art references is an 'essential component of an obviousness holding') (quoting *C.R. Bard, Inc. v. M3 Systems, Inc.*, 157 F.3d 1340, 1352, 48 USPQ2d 1225, 1232 (Fed. Cir. 1998)); *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references."); *In re Fine*, supra ("teachings of references can be combined only if there is some suggestion or incentive to do so.") (underline in original) (quoting *ACS Hosp. Sys., Inc. v. Montefiore Hosp.*, 732 F.2d 1572, 1577, 221 USPQ 929, 933 (Fed. Cir. 1984)).

The requirement for a prima facie case of obviousness under 35 USC §103 is that there must be:

"...some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references." *In re Fritch*, 972 F.2d 1260, 23 USPQ 2d 1780, 1783 (Fed. Cir. 1992). [underlining added]

In re Fritch (supra) was followed by *In re Dance* (160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998)) holding that there must be some motivation, suggestion, or teaching of the desirability of making the specific combination that was made by the applicant.

Thus, the Examiner's statement in the Office Action page 3, item 3#, fourth paragraph, is insufficient motivation for a combination:

"The admitted prior art and Wang et al. '237 are in the same field of endeavors."

Therefore, the Examiner's conclusion is erroneous in the Office Action page 3, item #3, fifth paragraph:

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"Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the admitted prior art with an entrant angle of greater than 69 degrees, as taught by Wang et al. (5629237), so as to prevent any voids when filling the via hole with metal material."

Based on the above, there is no teaching, suggestion, or motivation for combining the references based on current law.

Further, APA discloses that a problem related to filling of the channel and vias started to occur as the width of the channels and vias have decreased in size and that a solution has been long sought, but has not been found by those skilled in the art.

Wang discloses that the problem related to filling vias has been recognized for some time and that the solution disclosed is by improving the via beveling process. Wang also specifically states in col. 2, lines 17-18:

"The invention can be used with high aspect ratio contact via holes as well as regular contact via holes."

Thus, it is respectfully submitted that, even assuming *arguendo*, if those having ordinary skill in the art were to combine the references, the combination would only teach or suggest a channel with a beveled via to those having ordinary skill in the art.

It is respectfully submitted that claim 1, claim 11 for which the same reasons apply as claim 1, and the claims depending therefrom are now unobvious over APA in view of Wang taken either singularly or in combination under 35 USC 103(a).

The dependent claims 2-10 and 12-20 respectively depend from independent claims 1 and 11, and are believed to be allowable since they contain all the limitations set forth in the independent claims from which they depend and claim non-obvious combinations thereof.

Conclusion

In view of the above, it is submitted that the claims are in condition for allowance and reconsideration of the rejections is respectfully requested. Allowance of claims 1-20 at an early date is solicited.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this

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paper, including any extension of time fees, to Deposit Account No. 01-0365 and please credit any excess fees to such deposit account.

Respectfully submitted,

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